

MOTOR ADJUSTABLE HEADREST

The invention relates to a motor adjustable head rest for operating tables, which comprises a head plate, which is arranged at one end of a curved support shaft, which is guided in an adjustable manner in a plane which is perpendicular with respect to the axis of curvature on a support which can be connected to the operating table, between three rollers which are separated by an interval in the direction of adjustment.

Existing head rest systems can be divided into head rests whose position can be manually adjusted, and head rests with assistance for the lifting movement by an extraneous energy, such as, for example, an electromotor or a hydraulic drive. Particularly simple embodiments are limited to a sequential arrangement of several elements which can be rotated with respect to each other once the correct position has been found. In these simple systems, the load of the head plate must be borne by the operator during the adjustment procedure, which requires the use of both hands. Such an arrangement is not suitable for intraoperative adjustments.

Manual systems, which also allow an adjustment of the head plate during the intervention, continuously support the load. The vertical lifting in these cases is started by a mechanical drive which, on the one hand, ensures small adjustment forces and, on the other hand, its design on the load side is self-locking to prevent an undesired lowering of the head. Additional degrees of freedom of the head plate, such as, for example, lateral (horizontal) shifts or lateral pivoting movements can be stopped by simple clamp connections, because their adjustment requires almost no power.

As already mentioned, the vertical lifting can also be achieved using extraneous energy. Depending on the chosen system, one can also here omit the self-locking, so that the load of the weight is applied directly on the actuators.

In most known head rest systems, the path of the lifting movement can be reduced to the following forms:

Parallelogram guidance:

The head is placed on a crossbar, which is connected by two parallel control levers to the fixation points in the area of the patient's back. As a result, the head moves through a purely translational path, which corresponds to an arc of a circle.

Rotational guidance:

The head is placed on a crossbar, which is rotatably attached at a point under the patient and therefore it describes a circular path when it is adjusted. The goal is to achieve as large as possible a crossbar length, to carry out an approximately linear lifting movement of the head.

Haslinger head rest:

The Haslinger head rest corresponds to the head rest described in the introduction. To achieve a nearly anatomically correct adjustment movement of the head, the support shaft is formed by a segment of a circular ring, which is led through three rollers and which is driven via a gear-tooth system on the segment of a circular ring. This guidance allows the shifting of the center of the rotational movement of the head to the area above the patient bearing surface.

All the known head rest systems share the property that the adjustment movement is carried out by very simple movement shapes, which, depending on the mechanical constraining conditions, describe nearly linear or circular paths. These paths, however, do not correspond to human anatomy, so that compensatory movements of the head must occur. If this compensatory movement is prevented, for example, due to the positioning of the head in a head cap, the patient undergoes compression or stretching depending on the adjustment direction. If the patient is awake, he/she will briefly raise the head as the pain is felt, and thus produce a compensation. However, a relaxed patient does not have this possibility and remains in the given secured position.

The invention is based on the problem of providing a motor adjustable head rest of the type mentioned in the introduction, which is such that the head of a patient who is lying on the patient bearing surface of the operating table can follow an anatomically correct path during the lifting and the lowering of the head plate.

According to the invention, this problem is solved by shaping the tracks formed on the support shaft for the rollers in such a manner that their instantaneous curvature midpoints in each position of the support shaft coincide with the instantaneous center of rotation of the head movement during the lifting and lowering of the patient's head which is located on the head plate.

The solution according to the invention is based on an analysis of the anatomically correct movement of the head and the recognition that the vertebral column which connects the head to the body, in the technical implementation of the head rest system, can be considered to be a chain of elements. The vertebral column thus corresponds to the sequential arrangement of individual elements which are connected rotatably to each other, at appropriate intervals, and where each of the elements allows a certain amount of torsion, and the resistance acting against the torsion increases with increasing angle of torsion.

The extended and straight position is considered the middle position and the starting position in the following considerations. In the middle position, all the elements of the influenced area are arranged in a straight line. If the head is now lifted out of this position, this will first lead to a rotational movement in the rotating element which is farthest from the head, because there the force is applied with the greatest lever arm and causes the least torsion. However, with increasing rotation, the tension in this rotating element becomes greater than that of the rotating element closest to the head, so that the latter element is the only one which undergoes torsion. Thus the midpoint of the rotational movement, as the head is lifted higher, moves from the point at the greatest distance in the direction toward the head. The curve, which is described by the chain of elements, corresponds to a spiral which, starting in the horizontal direction, gradually curves upward with decreasing radius. For the movement of the head this means that, starting from a vertical lifting movement from the middle position, the head ideally follows a spiral with increasing curvature, whose instantaneous poles or centers migrate on the described midpoint spiral from the point at the greatest distance at the beginning of the lifting movement in the direction of the head.

As the head is lowered from the middle position downward, the same rules apply. The patient bearing surface restricts the number of elements participating in the movement to such an extent

that a spiral with a clearly narrower radius of curvature is produced. The last point of rotation here is located at the vertebral insertion point at the base of the skull.

The continuous movement of the point of rotation on the midpoint spiral can also be represented as discrete rotations about defined points of rotation, to simplify the technical solution, where the points of rotation are located on the midpoint spiral. The path of the head is then represented by a sequential arrangement of arcs of circles, which are in tangential contact to achieve a continuous movement and whose radii of curvature become increasingly smaller from the middle position in the direction of the final position.

If two points of a body are fixed during a planar movement, each additional point of the body is thus fixed in its position. In the same manner, the curve path of a point of a body, in this case the center of gravity of the head, can be described by the curve paths of at least two other points of the body. As a result, a movement curve of the head can be represented by a guide element which is applied to the head, and which is led in at least two places on different position-specific curve functions. In the solution according to the invention, this principle is now applied because the support shaft is clamped between three rollers, whose tracks which are formed on the support shaft also have a different shape because of the different positions of the rollers. The shapes of the tracks are derived from the desired movement of the head. In the process, at each point, the movement of rotation of the head about a point of rotation on the above described midpoint spiral is described by a rolling motion of the rollers on the tracks, whose corresponding instantaneous pole or curvature midpoint coincides with this point of rotation of the head. If at least two points of the supporting support shaft are led on concentric circular paths (achieved in each case by appropriate tracks with associated rollers), then all the points, which are rigidly connected to the support shaft and thus also to the head of the patient, move on sections of a circular path about the same center of rotation. The third roller prevents a lifting of the support shaft from the two mentioned rollers in the case of a change in the direction of load application, and it is preferably prestressed in the direction toward the support shaft to compensate for finishing tolerances.

In a preferred embodiment, the support is designed in the form of a housing which can be rigidly connected to the operating table, where the rollers are attached and the support shaft is guided in this housing.

The drive of the support shaft can be implemented in different manners. For example, the support shaft can carry a gear track into which a pinion which can be driven by a motor engages. In a preferred embodiment, the gear track is provided on a side surface of the support shaft, which is perpendicular to the axis of curvature of the support shaft, where the drive device, comprising the motor and the pinion, is attached in a movable manner to an axle which can be pivoted toward the side surface, in the support.

In an additional embodiment, the drive device comprise a threaded spindle which can be turned by a motor, which is supported on the support, and which engages in a nut which is attached in a manner so it can be moved to the support shaft.

In an additional embodiment, the drive device comprises a pulling element, which is attached to, or near, the two ends of the support shaft, and which is moved by a driving wheel which can be driven by a motor. This pulling element can here be a chain or a toothed belt, so that the support shaft can be set without slipping.

Finally, the drive device could also be formed from a hydraulic cylinder, which engages with the support shaft and which is supported on a support which is firmly attached to the table. This embodiment is particularly suitable for a headrest which is permanently connected to a hydraulically adjustable operating table.

Other characteristics and advantages of the invention will become apparent in the following description which explains the invention using an embodiment example and with reference to the drawing in the appendix. In the drawing:

Figures 1a-c show schematic representations of the movement of the head of a person who lies on his/her back,

Figure 2 shows a graphic representation to explain the technical implementation of the path curve for the movement of adjustment of the head plate,

- Figure 3 shows a schematic representation of the overall concept for the track curve of the head and the guidance of the headrest,
- Figure 4 shows a perspective overview of the motor adjustable headrest according to the invention,
- Figure 5 shows a representation of the headrest, which approximately corresponds to that of Figure 4, where a portion of the housing has been removed,
- Figure 6 shows a representation of the head rest, which corresponds to that of Figure 5, except that the view is from the opposite side, and
- Figure 7 shows a perspective view of the rod and the drive device.

Figures 1a-c show the curvature of the vertebral column during the up and down movements of the head of a patient who lies on the back. Reference numeral 10 denotes the patient bearing area of an operating table, on which a head plate 12 is arranged in an adjustable manner. On the head plate 12, the head 14 of a patient 16 who lies on the patient bearing surface 10 rests. Reference numeral 18 denotes the center of gravity of the head.

Figure 1b shows the patient 16 in the stretched position, where the head plate 12 is in alignment with the patient bearing surface 10, and the vertebral column 20 of the patient forms a straight line. If the head 14 of the patient is lifted by means of the head plate 12, the vertebral column curves along the path 20' in Figure 1a. If the head 14 is moved downward by lowering the head plate 12, then the vertebral column follows the path 20" in Figure 1c. One can see that the vertebral column does not perform a pivoting movement about a fixed center of rotation and that the paths 20' and 20" present different curvatures.

Figures 2 and 3 are intended to explain how the head plate 12 can be adjusted in such a manner that the center of gravity 18 of the head 14, during the lifting and lowering of the head plate 12, follows its anatomically correct path, which is denoted 22 in Figures 2 and 3.

The head plate 12 is attached to one end of a support shaft 24, which is guided in a manner so it can be shifted between 3 rollers 26, 28 and 30 in the plane of the drawing. The rollers 26, 28, 30 here are applied against the tracks 32, 34 and 36, respectively, which are formed on the support

shaft 24. These tracks 32, 34, 36 are composed of different sections, which are designed as schematically explained in Figure 2.

Figure 2 shows a certain position of the head or a time in the adjustment movement of the head, at which the center of gravity of the head 18' is at the point on the movement path 22 which is represented in Figure 2. The associated center of rotation in the vertebral column, that is on path 20" is located at the point denoted Z_{mom} . The center of gravity of the head 18 is rigidly connected via the head plate to the support shaft 24 in Figure 3. The rollers 26, 28, 30 in each case are located at a point 26', 28', 30' on the associated track 32, 34, 36. The points 26', 28', 30' are also points of the support shaft 24, and thus they are rigidly connected to the center of gravity of the head. The four points 18', 26', 28' and 30' can thus only perform a joint movement of rotation about the instantaneous center of rotation Z_{mom} if the instantaneous curvature midpoints of the tracks 32, 34, 36 coincide with the instantaneous center of rotation Z_{mom} , that is, the rollers 26, 28, 30 at all times run on concentric sections of a circular path having the center Z_{mom} .

Under this condition, when a current or instantaneous center of rotation Z_{mom} is shifted along the paths 20" and 20', the associated sections of the tracks 32, 34, 36 are determined. Aligned one after the other, they form the corresponding tracks 32, 34 and 36. The tracks are all different. However, when combined, due to the rolling movement on the corresponding rollers 26, 28 and 30, respectively, they produce the desired movement path of the head plate 12 and thus of the center of gravity of the head 18.

Figures 4-7 are only schematic representations with reference to a preferred embodiment of the technical implementation of the headrest according to the invention. In the figure, one can locate the housing which has the general reference numeral 38, and substantially consists of two parallel plates 40, 42, which are kept apart by an interval and connected to each other by the bolt 44. Between the plates 40 and 42, the rollers 26, 28 and 30 are rotatably attached to axles which are perpendicular to the plates 40 and 42, between which axles the support shaft 24 is led. In Figure 6, one can see the tracks 32, 34 and 36, which are formed on the support shaft 24, and intended for the rollers 26, 28 and 30, respectively. The support shaft 24 carries a ledge 46 at one end, to which the head plate 12, not shown in Figures 4-7, can be attached. Moreover, the handle 48 is attached to this end of the support shaft 24, by means of which the support shaft can be

moved by hand. Above the roller 28, a cover plate 50, which can be seen in Figure 6, is located; its purpose is to prevent objects, in particular a patient's hair, to be grabbed by the roller 28 and pulled into the housing 38.

The support roller 30 is prestressed by a spring 52 in the direction to the track 36.

The drive for the adjustment of the support shaft 24 is explained in Figure 7. The support shaft 24 carries, on one of its longitudinal sides, a gear track 54, into which a pinion 56 engages, which is driven via a worm gear drive 58 by a motor 60. The drive device or component which consists of the motor 60, the worm gear drive 58 and the pinion 56, is attached by means of a rotating disk 64 in a manner so it can be pivoted about an axle 66, in a plate 62 which is screwed to the external side of the housing plate 42 so that the pinion 56 can follow the direction of the teeth of the gear track 54 which changes when the support shaft 24 is adjusted. The drive device, in practice, is covered by a cover – not shown – which is attached to the plate 62.

The housing 38 can be attached with the help of a support – not shown – on the frame of the operating table or of the patient bearing surface 10.

Claims

1. Motor adjustable head rest for operating table, comprising a head plate (12), which is arranged at one end of a curved support shaft (24), which is guided in an adjustable manner, in a plane which is perpendicular to the axis of curvature on a support (38) which can be connected to the operating table, between three rollers (26, 28, 30) which are separated by an interval in the adjustment direction, characterized in that the tracks (32, 34, 36), formed on the support shaft (24), for the rollers (26, 28, 30) are shaped in such a manner that their instantaneous curvature midpoints in each position of the support shaft (24) coincide with the instantaneous center of rotation Z_{mom} of the head movement during the lifting and lowering of a patient's head (14) which rest on the head plate (12).
2. Head rest according to Claim 1, characterized in that two of the tracks (32, 36) point downward and one track (34) points upward.
3. Head rest according to Claim 1 or 2, characterized in that one of the rollers (30) supporting the support shaft (24) is prestressed in the direction to the support shaft (24).
4. Head rest according to one of Claims 1-3, characterized in that the support comprises a housing (38) which can be rigidly connected to the operating table, in which the rollers (26, 28, 30) are attached, and the support shaft (24) is led.
5. Head rest according to one of Claims 1-4, characterized in that the support shaft (24) supports a gear track (54), in which a pinion (56) which can be driven by a motor (60) engages.
6. Head rest according to Claim 5, characterized in that the gear track (54) is formed on a side surface of the support shaft which is perpendicular to the axis of curvature of the support shaft (24), and in that the drive device, comprising the motor (60) and the pinion (56), is attached to the support (38) in such a manner that it can be moved about a pivoting axle (66) which is perpendicular to the side surface.

7. Head rest according to one of Claims 1-4, characterized in that the drive device comprises a threaded spindle which can be rotated by a motor, which rests on the support, and which engages in a nut which is attached in a movable manner to the support shaft.
8. Head rest according to one of Claims 1-4, characterized in that the drive device comprises a pulling element, which is attached on, or near, the two ends of the support shaft and which is moved by a drive wheel which can be driven by a motor.
9. Head rest according to one of Claims 1-4, characterized in that the drive device comprises a hydraulic cylinder which rest on a support.